963561

Attach # 1

[NAME OF THE DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] Composite Motor

[SCOPE OF THE CLAIMS]

[CLAIM 1]

A composite motor provided with

a first and second rotor disposed coaxially;

a stator opposing a plurality of armature coils to the first rotor, the armature coils provided on an outer periphery of the first rotor; and

a magnetic body transmitting a magnetic field respectively generated by the plurality of armature coils on the stator to the second rotor.

[CLAIM 2]

The composite motor as defined by Claim 1 wherein the magnetic body is provided with

a first core facing the armature coils of the stator and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction;

a second core facing the second rotor and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction; and

a third core between the first and the second core comprising steel plates laminated in a radial direction from an axial center which is parallel to the axial direction.

[CLAIM 3]

The composite motor as defined by Claim 1 wherein the magnetic body is provided with

a first core facing the armature coils of the stator and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction; and

a third core between the first core and opposed to the second rotor comprising steel plates laminated in a radial direction from an axial center which is parallel to the axial direction.

[CLAIM 4]

A composite motor provided with

a first and second rotor disposed coaxially;

a first stator opposing a plurality of armature coils to the first rotor, the first stator provided on an outer periphery of the first rotor;

a second stator opposing an equal number of armature coils as the first stator to the second rotor, the armature coils are provided on an outer periphery of the second rotor; and

a magnetic body transmitting mutually opposite magnetic fields respectively generated by the plurality of armature coils on the first and the second stator; and

the armature coils of the first and the second stator are connected in series.

[CLAIM 5]

The composite motor as defined by Claim 4 wherein the magnetic body is provided with

a first core facing the armature coils of the first stator and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction;

a second core facing the armature coils of the second stator and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction; and

a third core between the first core and the second rotor comprising steel plates laminated in a radial direction from an axial center which is parallel to the axial direction.

[CLAIM 6]

The composite motor as defined in any one of Claims 2, 3 or 5 wherein the magnetic body is provided with an indentation parallel to an

axial direction is provided on an outer periphery of the first or the second core; and

a connecting part comprising the indentation engaging with a projection is provided in the third core.

[CLAIM 7]

The composite motor as defined in any one of Claim 1 or Claim 4 wherein each armature coil of the stator is wound independently on the stator in order to increase the mutual magnetic resistance.

[CLAIM 8]

The composite motor as defined in any one of Claims 2, 3 or 5 provided with a case member which retains the third core and which has a water jacket through which cooling water flows.

[CLAIM 9]

The composite motor as defined in any one of Claims 2, 3 or 5 provided with a magnetic shield on an outer periphery of the case member which retains the third core.

[CLAIM 10]

The composite motor as defined in any one of Claims 2, 3 or 5 provided with a wedging pin having a plurality of shapes insertable between the stator and the case member which retains the third core, and

a stopper which fixes the wedging pin.

[DETAILED DESCRIPTION OF THE INVENTION]

[FIELD OF THE INVENTION]

The present invention relates a rotating electrical motor. In particular this invention relates to a composite motor which drives two rotors which a single stator.

[PRIOR ART]

A conventional composite motor drives two rotors with one stator as shown for example in Fig. 7.

That is to say, as shown in Fig. 7, a stator 203 is mounted on a case 201 and an outer rotor 205 rotates freely on an outer periphery of the stator 203. Furthermore an inner rotor 207 is provided which rotates freely on an inner periphery of the stator 203.

[PROBLEM TO THE SOLVED BY THE INVENTION]

However this type of conventional synchronous motor has a cantilever structure in which due to the fact that the stator 203 is inserted between the inner rotor 207 and the outer rotor 205, it is mounted on the case only near the side of the stator 203.

When connecting a torque repulsive force to the case 201 from the two rotors 205, 207 which is supported by the stator 203, there are difficulties with respect to a structure of mounting the stator 203 on the case 201. Furthermore the problem arises that the rigidity of the stator 203 can not be increased.

Furthermore the problem has also arisen that circulation of the water jacket which cools the stator 203 is difficult and the cooling performance of the stator 203 can not be increased.

The present invention is proposed to solve the above problems and has the object of providing a composite motor which increases the rigidity of the stator and which facilitates cooling performance.

[MEANS FOR SOLVING THE PROBLEM]

In order to solve the above problem, an invention as claimed in Claim 1 is provided with a first and second rotor disposed coaxially; a stator opposing a plurality of armature coils to the first rotor, the armature coils provided on an outer periphery of the first rotor; and a magnetic body transmitting a magnetic field respectively generated by the plurality of armature coils on the stator to the second rotor.

In order to solve the above problem, an invention as claimed in Claim 2 is provided with a the magnetic body comprising a first core facing the armature coils of the stator and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction; a second core facing the second rotor and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction; and a third core between the first and the second core comprising steel plates laminated in a radial direction from an axial center which is parallel to the axial direction.

In order to solve the above problem, an invention as claimed in

Claim 3 is provided with a magnetic body comprising a first core facing the armature coils of the stator and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction; and a third core between the first core and opposed to the second rotor comprising steel plates laminated in a radial direction from an axial center which is parallel to the axial direction.

In order to solve the above problem, an invention as claimed in Claim 4 is provided with a first and second rotor disposed coaxially; a first stator opposing a plurality of armature coils to the first rotor, the first stator provided on an outer periphery of the first rotor; a second stator opposing an equal number of armature coils as the first stator to the second rotor, the armature coils are provided on an outer periphery of the second rotor; and a magnetic body transmitting mutually opposite magnetic fields respectively generated by the plurality of armature coils on the first and the second stator. The invention is further characterized in that the armature coils of the first and the second stator are connected in series.

In order to solve the above problem, an invention as claimed in Claim 5 is provided with a magnetic body comprising a first core facing the armature coils of the first stator and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction; a second core facing the armature coils of the second stator and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction; and a third core between the first core and the second rotor comprising steel plates laminated in a radial direction from an axial center which is parallel to the axial direction.

In order to solve the above problem, an invention as claimed in Claim 6 is provided with a magnetic body comprising an indentation parallel to an axial direction is provided on an outer periphery of the first or the second core; and a connecting part comprising the indentation engaging with a projection is provided in the third core.

In order to solve the above problem, an invention as claimed in Claim 7 is characterized in that each armature coil of the stator is wound independently on the stator in order to increase the mutual magnetic resistance.

In order to solve the above problem, an invention as claimed in Claim 8 is provided with a case member which retains the third core and which has a water jacket through which cooling water flows.

In order to solve the above problem, an invention as claimed in Claim 9 is provided with a magnetic shield on an outer periphery of the case

member which retains the third core.

In order to solve the above problem, an invention as claimed in Claim 10 is provided with a wedging pin having a plurality of shapes insertable between the stator and the case member which retains the third core, and a stopper which fixes the wedging pin.

[EFFECT OF THE INVENTION]

In the invention according to Claim 1, a first rotor and a second rotor are disposed coaxially. A plurality of armature coils of the stator which are disposed on an outer periphery of the first rotor face the first rotor. Respective magnetic fields generated by the plurality of armature coils of the stator are transmitted to the second rotor using the magnetic body. Thus this is not a cantilevered structure as in the conventional example. Thus it is possible to ensure stopping of the torque repulsive force which is generated by the rotation of the rotor through the stator with the motor case. It is also possible to increase the rigidity of the stator.

In the invention according to Claim 2, a magnetic body is provided comprising a first core facing the armature coils of the stator and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction; a second core facing the second rotor and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction; and a third core between the first and the second core comprising steel plates laminated in a radial direction from an axial center which is parallel to the axial direction. Since the respective magnetic fields generated by the plurality of armature coils of the stator are transmitted to the second rotor, it is possible to form a composite motor in which the first and second rotors are disposed coaxially and therefore increase the rigidity of the stator.

In the invention according to Claim 3, a magnetic body is provided with a magnetic body comprising a first core facing the armature coils of the stator and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction; and a third core between the first core and opposed to the second rotor comprising steel plates laminated in a radial direction from an axial center which is parallel to the axial direction. Since the respective magnetic fields generated by the plurality of armature coils of the stator are transmitted to the second rotor, it is possible to form a composite motor in which the first and second rotors are disposed coaxially and therefore increase the rigidity of the stator.

In the invention according to Claim 4, the invention is provided with a first and second rotor disposed coaxially; a first stator opposing a plurality

of armature coils to the first rotor, the first stator provided on an outer periphery of the first rotor; a second stator opposing an equal number of armature coils as the first stator to the second rotor, the armature coils are provided on an outer periphery of the second rotor; and a magnetic body transmitting mutually opposite magnetic fields respectively generated by the plurality of armature coils on the first and the second stator. The invention is further characterized in that the armature coils of the first and the second stator are connected in series. Thus this is not a cantilevered structure as in the conventional example. Therefore it is possible to ensure stopping of the torque repulsive force which is generated by the rotation of the rotor through the stator with the motor case. It is also possible to increase the rigidity of the stator.

In the invention according to Claim 5, the invention is provided with a magnetic body comprising a first core facing the armature coils of the first stator and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction; a second core facing the armature coils of the second stator and comprising steel plates laminated in a planar direction which is orthogonal to the axial direction; and a third core between the first core and the second rotor comprising steel plates laminated in a radial direction from an axial center which is parallel to the axial direction. Since respectively opposite magnetic fields generated by the plurality of armature coils of the first stator and the second stator are transmitted, it is possible to form a composite motor disposing the first and the second rotors coaxially. It is also possible to increase the rigidity of the stator.

In the invention according to Claim 6, the invention is provided with a magnetic body comprising an indentation parallel to an axial direction is provided on an outer periphery of the first or the second core; and a connecting part comprising the indentation engaging with a projection is provided in the third core. Thus the magnetic body can be formed without welding the plurality of cores and it is possible to simplify the assembly of the composite motor. Furthermore it is also possible to increase the rigidity of the stator.

In the invention according to Claim 7, each armature coil of the stator is wound independently on the stator in order to increase the mutual magnetic resistance. Thus a torque repulsive force in the armature coils generated by the rotation of the rotor can be stopped by the motor case through the stator.

In the invention according to Claim 8, a case member which retains the third core and which has a water jacket through which cooling water flows. Thus the cooling of the composite motor is facilitated.

In the invention according to Claim 9, a magnetic shield is provided on an outer periphery of the case member which retains the third core. Thus it is possible to prevent the leakage of high frequency components resulting from variations in magnetic flux to the outside.

In the invention according to Claim 10, a wedging pin having a plurality of shapes insertable between the stator and the case member which retains the third core, and a stopper which fixes the wedging pin. Thus it is possible to simplify the assembly of the composite motor and it is also possible to increase the rigidity of the stator.

[DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS]

The present invention will be described with reference to the accompanying figures.

(First Embodiment)

Fig. 1 is a lateral cross sectional view of the structure of a composite motor 11 according to a first embodiment of the present invention. Fig. 2 is an upper cross sectional view of the structure of a composite motor 11 according to a first embodiment of the present invention. In more detail, the cross sectional faces due to the line A – A line or the line B – B line as shown in Fig. 1 are designated as the face A – A and the face B – B.

Firstly the structure of a composite motor 11 will be described with reference to Fig. 1 and Fig. 2.

The composite motor 11 has a stator 13 which has a plurality of armature coils and a small radius first rotor 15 and a large radius second rotor 17 which have permanent magnets provided on an inner periphery of the stator 13 are aligned coaxially as shown in Fig. 1. As shown in Fig. 2, the number of magnetic poles of the first rotor 15 is set to six for example and the number of the magnetic poles of the second rotor 17 is set to eight for example. The number of magnetic poles of both rotors is set to different values.

Twelve first cores 19 on which armature coils are concentrated wound on a position facing the outer peripheral of the first rotor 15 are provided on the stator 13. A second core 21 is provided at a position facing the outer periphery of the second rotor 17. Twelve third cores 23 connected to the cores are provided on the outer periphery of the first core 19 and the second core 21.

An indentation having a depressed shape which is formed by

pressing or machining the connecting part 24 of the third core 23 is provided on the first core 19 and the second core 21. A projection 27 having a protruding shape which projects from the laminated plate to the center is provided on the third core 23.

The third core 23 has an approximately rectangular shape and is disposed in the stator 13 radiating towards a circular periphery. A case member 29 is disposed from an outer periphery to an inner side between the respective radially disposed third cores 23. A first water jacket (WJ) 31, a second water jacket (WJ) 33 which allow flow of cooling water and a bolt hole 35 are provided.

A first core 19 and the second core 21 are fixed using a wedge 37 in order not to allow inward movement. The third core 23 is fixed by the case 39 in order not to allow outward movement. The wedge 37 is fixed by a stopper 41 which comprises a ring-shaped groove on both axial ends. The wedge 37 is pressed outwardly by an intermediate ring 43 which is inserted between the first core and the second core. The intermediate ring 43 has the function of a spacer which stops movement in an axial direction.

A magnetic shield 45 which comprises mesh plate or thin steel plate is provided on an outer periphery of the third core.

The first rotor 15 has a structure in which a first rotation shaft 51 is fixed to rotate freely on the case 39 through a first bearing 53 and takes motive force from both axial ends of the first rotation shaft 51. Furthermore a second rotor 17 has a structure in which a second rotation shaft 57 is fixed to rotate freely on a first rotation shaft 51 through a second bearing 55 and a third bearing 59 and further the second rotation shaft 57 is fixed to rotate freely on a case 39 through a fourth bearing 61. Thus the first rotor 15 takes motive force from one axial end of the second rotation shaft 57.

Next the combined structure and effect characterizing the composite motor 11 will be described with reference to Fig. 1 and Fig. 2.

A first rotor 15 and a second rotor 17 are disposed coaxially. A plurality of armature coils of the stator 13 which are disposed on an outer periphery of the first rotor 15 face the first rotor 15. Respective magnetic fields generated by the plurality of armature coils of the stator 13 are transmitted to the second rotor 17 using the magnetic body comprising the first core 19, the second core 21 and the third core 23. Thus this is not a cantilevered structure as in the conventional example. Thus it is possible to ensure stopping of the torque repulsive force which is generated by the rotation of the first rotor 15 and the second rotor 17 through the stator 13 with the case 39 and it is possible to increase the rigidity of the stator.

A first core 19 which comprises steel plate laminated in a planar direction which is orthogonal to an axial direction is opposed to the armature coils of the stator 13. A second core 21 which comprises steel plate laminated in a planar direction which is orthogonal to an axial direction is opposed to the second rotor 17. A third core 23 which comprises laminated steel plate radiating from an axial center parallel to the axial direction is provided between the first core 19 and the second core 21. Thus respective rotating magnetic fields generated by the plurality of armature coils of the stator 13 are transmitted to the second rotor 17. As a result, it is possible to form a composite motor 11 which disposes the first rotor 15 and the second rotor 17 coaxially and to greatly increase the rigidity of the stator.

In the magnetic body as described above, a connecting part 24 is provided which comprises an indentation 25 (depression) parallel to an axial direction of the outer periphery of the first core 19 or the second core 21 and a projection 27 (protrusion) engaging with an indentation 25 (depression) in the third core 23. Thus the first core 19, the second core 21 and the third core 23 are respectively separated. As a result, it is possible to form a magnetic body as described above without welding a plurality of cores. It is possible to assemble the composite motor 11 in a simple manner and furthermore to greatly increase the rigidity of the stator.

Each armature coil of the stator 13 is wound independently on the stator 13 to increase the mutual magnetic resistance. Thus it is possible to ensure stopping the torque repulsive force between each armature coil generated by the rotation of the first rotor 15 through the stator 13 with the motor case 39.

The stator 13 generates heat together with variations in the magnetic flux. Thus a case member 29 is provided which retains a third core 23 and has water jackets WJ 31, 33 which allow flow of the cooling water. Thus cooling of the composite motor 11 is facilitated. As a result, the cooling of the stator is greatly improved and since the third core comes into contact with the case in three directions, cooling efficiency is improved.

Since an magnetic shield 45 comprising thin steel plate or mesh plate is provided on an outer periphery of the case member 29 which retains the third core 23, it is possible to prevent leakage to the outside of high frequency components resulting from the variation in the magnetic flux.

Since a wedge pin 37 which has a plurality of shapes and a stopper 41 which fixes the wedge pin 37 are provided, the most suitable wedge pin 37 is selected and fixed and inserted between the stator 13 and the case member 29 which retains the third core 23. Since the wedge pin 37 is fixed

in this manner by the stopper 41, simple assembly is possible without welding the composite motor 11. Thus it is possible to ensure stopping the torque repulsive force which is generated by the rotation of the first rotor 15 and the second rotor 17 through the stator 13 by the motor case 39. Furthermore it is possible to greatly increase the rigidity of the stator.

(Second Embodiment)

Fig. 3 is a lateral cross sectional view of the structure of a composite motor 71 according to a second embodiment of the present invention. Fig. 4 is an upper cross sectional view of the structure of a composite motor 71 according to a second embodiment of the present invention. In more detail, the cross sectional faces due to the line A – A line or the line B – B line as shown in Fig. 3 are designated as the face A – A and the face B – B.

Firstly the structure of a composite motor 71 will be described with reference to Fig. 3 and Fig. 4. The second embodiment has basically the same structure as the composite motor in the first embodiment as shown in Fig.1 and Fig. 2. Those components which are the same are designated by the same reference numerals and additional description will be omitted.

The characteristic of this embodiment is that the device is provided with a first core 19 facing the armature coil of the stator 13 and comprising steel plate laminated with respect to a planar direction orthogonal to the axial direction and a third core 73 comprising steel plate laminated in a radial direction from the axial center and parallel to an axial direction is provided between the first core 19 and facing the second rotor 17.

The assembled structure and effect of the composite motor 71 will be described with reference to Fig. 3 and Fig. 4. Additional description of aspects of the structure and effect which are the same as those described with reference to the first embodiment will be omitted.

A first rotor 15 and a second rotor 17 are disposed coaxially. A plurality of armature coils of the stator 13 which are disposed on an outer periphery of the first rotor 15 face the first rotor 15. Respective magnetic fields generated by the plurality of armature coils of the stator 13 are transmitted to the second rotor 17 using the magnetic body comprising the first core 19 and the third core 23. Thus this is not a cantilevered structure as in the conventional example. Therefore it is possible to ensure stopping of the torque repulsive force which is generated by the rotation of the first rotor 15 and the second rotor 17 through the stator 13 with the case 39. It is possible to increase the rigidity of the stator.

In this magnetic body, a first core 19 which comprises steel plate

laminated in a planar direction which is orthogonal to an axial direction is opposed to the armature coils of the stator 13. A third core 23 which comprises laminated steel plate radiating from an axial center parallel to the axial direction is provided between the first core 19 and facing the second rotor 17. Thus the magnetic body has a structure in which respective rotating magnetic fields generated by the plurality of armature coils of the stator 13 are transmitted to the second rotor 71. As a result, it is possible to form a composite motor 11 which disposes the first rotor 15 and the second rotor 17 coaxially and to greatly increase the rigidity of the stator.

In the magnetic body as described above, a connecting part 24 is provided which comprises an indentation 25 (depression) parallel to an axial direction on the outer periphery of the first core 19 and a projection 27 (protrusion) engaging with an indentation 25 (depression) in the third core 23. As a result, it is possible to form a magnetic body as described above without welding a plurality of cores. It is possible to assemble the composite motor 11 in a simple manner and furthermore to greatly increase the rigidity of the stator.

Each armature coil of the stator 13 is wound independently on the stator 13 to increase the mutual magnetic resistance. Thus it is possible to ensure stopping the torque repulsive force between each armature coil generated by the rotation of the first rotor 15 through the stator 13 with the motor case 39.

(Third Embodiment)

Fig. 5 is a lateral cross sectional view of the structure of a composite motor 81 according to a third embodiment of the present invention. Fig. 6 is an upper cross sectional view of the structure of a composite motor 81 according to a third embodiment of the present invention. In more detail, the cross sectional faces due to the line A – A line or the line B – B line as shown in Fig. 5 are designated as the face A – A and the face B – B.

Firstly the structure of a composite motor 81 will be described with reference to Fig. 5 and Fig. 6. The second embodiment has basically the same structure as the composite motor in the first embodiment as shown in Fig.1 and Fig. 2. Those components which are the same are designated by the same reference numerals and additional description will be omitted.

The characteristic of this embodiment is that the motor is provided with a first rotor 83 and a second rotor 85 which are disposed coaxially, a first stator 87 which opposes a plurality of armature coils to a first rotor 83 and which is provided on an outer periphery of the first rotor 83, a second

stator 89 which opposes the same number of armature coils as the first stator 87 provided on an outer periphery of the second rotor 85 to the second rotor 85, and a magnetic body comprising the first core 91, the second core 93 and the third core 95 is provided in order to transmit respective opposite magnetic fields generated by the plurality of armature coils of the first stator 87 and the second stator 89.

The magnetic body comprises a first core 91 comprising steel plates laminated in a planar direction orthogonal to an axial direction and facing the armature coils of the first stator 87, a second core 93 comprising steel plates laminated in a planar direction orthogonal to an axial direction and facing the armature coils of the second stator 98 and a third core 95 comprising steel plates laminated in a radial direction from an axial center parallel to the axial direction between the first core 91 and the second core 93.

As shown in Fig. 5, the second rotor 85 has a structure in which the second rotation shaft 97 is fixed to rotate freely on the first rotation shaft 51 through a first needle bearing 99 and a second needle bearing 101 and the second rotation shaft 97 is fixed to rotate freely on the case 39 through a fourth needle bearing. Thus a motive force is transmitted from one axial end of the second rotation shaft 97.

The assembled structure and effect of the composite motor 81 will be described with reference to Fig. 5 and Fig. 6. Additional description of aspects of the structure and effect which are the same as those described with reference to the first embodiment will be omitted.

A first rotor 83 and a second rotor 85 are disposed coaxially. A plurality of armature coils of the first stator 87 which is disposed on an outer periphery of the first rotor 83 face the first rotor 83. A number of armature coils in the second stator 89 which is equal to those of the first stator 87 which is provided on the outer periphery of the second rotor 85 are opposed to the second rotor 85. Respectively opposite magnetic fields generated by the plurality of armature coils of the first stator 87 and the second stator 89 are transmitted to the second rotor 17 using the magnetic body comprising the first core 91 the second core 93 and the third core 95. The armature coils of the first stator 87 and the second stator 89 are connected in series. Thus this is not a cantilevered structure as in the conventional example. Therefore it is possible to ensure stopping of the torque repulsive force which is generated by the rotation of the first rotor 83 and the second rotor 85 through the stator with the motor case. It is possible to increase the rigidity of the stator.

In this magnetic body, a first core 91 which comprises steel plate

laminated in a planar direction which is orthogonal to an axial direction is opposed to the armature coils of the first stator 87. A second core 93 which comprises steel plate laminated in a planar direction which is orthogonal to an axial direction is opposed to the armature coils of the second stator 89. A third core 95 which comprises laminated steel plate radiating from an axial center parallel to the axial direction is provided between the first core 91 and the second core 93. Thus respective mutually opposite magnetic fields generated by the plurality of armature coils of the first stator 87 and the second stator 89 are mutually transmitted. As a result, it is possible to form a composite motor 81 which disposes the first rotor 83 and the second rotor 85 coaxially and to greatly increase the rigidity of the stator.

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 is lateral cross sectional view of a composite motor 11 according to a first embodiment of this invention.

Fig. 2 is an upper cross sectional view of a composite motor 11 according to a first embodiment of this invention.

Fig. 3 is lateral cross sectional view of a composite motor 71 according to a second embodiment of this invention.

Fig. 4 is an upper cross sectional view of a composite motor 71 according to a second embodiment of this invention.

Fig. 5 is lateral cross sectional view of a composite motor 81 according to a third embodiment of this invention.

Fig. 6 is an upper cross sectional view of a composite motor 81 according to a third embodiment of this invention.

Fig. 7 is a lateral cross sectional view of the schematic structure of a convention composite motor.

[EXPLANATION OF THE NUMERALS]

11 COMPOSITE MOTOR
13 STATOR
15 FIRST ROTOR
17 SECOND ROTOR
19 FIRST CORE
21 SECOND CORE
23 THIRD CORE
24 CONNECTING PART

25	INDENTATION
27	PROJECTION
29	CASE MEMBER
31	FIRST WATER JACKET (WJ)
33	SECOND WATER JACKET (WJ)
35	BOLT HOLE
37	WEDGE
39	CASE
41	STOPPER
43	INTERMEDIATE RING
45	MAGNETIC SHIELD
51	FIRST ROTATION SHAFT
57	SECOND ROTATION SHAFT

Attach # 2
963864

[NAME OF THE DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] Motor with plurality of rotors

[SCOPE OF THE CLAIMS]

[CLAIM 1]

A motor with plurality of rotors disposing a plurality of stator armatures facing a plurality of rotors which independently rotate and which have differing numbers of pairs of magnetic poles; the electrical phase number of the armatures is equal and the electrical phases drive the motor with a composite total of currents corresponding to the plurality of rotors.

[CLAIM 2]

The motor with plurality of rotors as defined by Claim 1 wherein coils of equal polarity corresponding to the plurality of stator armatures are connected in series.

[CLAIM 3]

The motor with plurality of rotors as defined by Claim 1 wherein coils of equal polarity corresponding to the plurality of stator armatures are connected in parallel.

[CLAIM 4]

A motor with plurality of rotors disposing one stator armature facing a plurality of rotors which independently rotate and which have differing numbers of pairs of magnetic poles; the electrical phases of the stator armatures drive the motor with a composite total of currents corresponding to the plurality of rotors.

[CLAIM 5]

The composite motor as defined by any one of Claim 1 to Claim 4 wherein the plurality of rotors and the stator armatures are stored in a single case.

[DETAILED DESCRIPTION OF THE INVENTION]

[FIELD OF THE INVENTION]

The present invention relates a motor provided with a plurality of

rotors.

[PRIOR ART]

A rotating electrical motor which is provided with a plurality of independently rotating rotors and a single stator is disclosed for example in JP-A-8-340663.

[PROBLEM TO THE SOLVED BY THE INVENTION]

However since this type of conventional rotating electrical motor rotates two independent rotors in synchrony, coils designated for each rotor are provided in the stator. Furthermore two inverters must be provided in order to control the current flowing in each of the designated coils. Thus the problem has arisen that loss due to the current flowing in the respective inverters can not be avoided.

The present inventors have disclosed a rotating electrical motor in JP-A-10-077449. This motor has two rotors which have magnets with differing numbers of magnetic poles and shares magnetic circuits. The rotors can be independently rotated by passing a composite current in the common coils.

The present invention relates to further improvements to the rotating electrical motor which has been invented by the present inventors. This invention has the object of providing a motor with a plurality of rotors which uses cylindrical rotors separated in a forward and reverse (hereafter lengthwise) direction as the plurality of rotors and increases their rotation speed.

[MEANS FOR SOLVING THE PROBLEM]

A motor with plurality of rotors as claimed in Claim 1 is provided with a plurality of stator armatures facing a plurality of rotors which independently rotate and which have differing numbers of pairs of magnetic poles. The electrical phase number of the armatures is equal and the electrical phases drive the motor with a composite total of currents corresponding to the plurality of rotors.

The motor with plurality of rotors as defined by Claim 2 comprises the invention as claimed in Claim 1 and is characterized in that coils of equal polarity corresponding to the plurality of stator armatures are connected in series.

The motor with plurality of rotors as defined by Claim 3 comprises

the invention as claimed in Claim 1 and is characterized in that coils of equal polarity corresponding to the plurality of stator armatures are connected in parallel.

The motor with plurality of rotors as defined by Claim 4 is characterized in that one stator armature faces a plurality of rotors which independently rotate and which have differing numbers of pairs of magnetic poles. The electrical phases of the stator armatures drive the motor with a composite total of currents corresponding to the plurality of rotors.

The motor with plurality of rotors as defined by Claim 5 comprises the invention as claimed in any one of Claim 1 to Claim 4 and is characterized in that the plurality of rotors and the stator armatures are stored in a single case.

[EFFECT OF THE INVENTION]

The invention according to Claim 1 is adapted to dispose a plurality of stator armatures facing a plurality of rotors which independently rotate and which have differing numbers of pairs of magnetic poles. The electrical phase number of the armatures is equal and the electrical phases drive the motor with a composite total of currents corresponding to the plurality of rotors. Thus the plurality of rotors and the stator armatures do not share the magnetic field circuit. Furthermore although the motors are mutually independent, the plurality of rotors can be rotated at the same time at different speeds by supplying a current from a common inverter (composite current) to the plurality of stator armatures.

In this manner, it is possible to displace a plurality of rotors lengthwise and to increase the rotation speed by using a cylindrical member for the plurality of rotors. Since the plurality of rotors are disposed lengthwise, poles of equal polarity in the permanent magnets of the rotors are not opposed and therefore no demagnetization effect results. As a result it is possible to maintain magnetic properties for long periods.

According to the invention as claimed in Claim 2, in addition to the invention in Claim 1, coils of equal polarity corresponding to the plurality of stator armatures are connected in series. Thus it is possible to rotate the plurality of rotors at independent rotation speeds and torque by supplying a drive current from a common inverter to the plurality of stator armatures.

According to the invention as claimed in Claim 3, in addition to the invention in Claim 1, coils of equal polarity corresponding to the plurality of stator armatures are connected in parallel. Thus it is possible to rotate the plurality of independent motors at the same time at different rotation

speeds by supplying the same current (composite current) from one inverter.

According to the invention as claimed in Claim 4, one stator armature is disposed facing a plurality of rotors which independently rotate and which have differing numbers of pairs of magnetic poles. The electrical phases of the stator armatures drive the motor with a composite total of currents corresponding to the plurality of rotors. Thus it is possible to rotate the plurality of rotors at the same time at different rotation speeds by supplying a composite current from one inverter to the single stator armature. Moreover it is possible to arrange the plurality of rotors lengthwise in an axial direction and to assemble a structure in which cylindrical stator armatures are disposed to encircle the outer periphery of the rotors. In this manner, it is possible to use cylindrical members as the plurality of rotors and therefore to increase the rotation speed. Since the plurality of rotors are disposed lengthwise, poles of equal polarity in the permanent magnets of the rotors are not opposed and therefore no demagnetization effect results. As a result it is possible to maintain magnetic properties for long periods.

According to the invention as claimed in Claim 5, in addition to the invention in Claims 1 to 4, the plurality of rotors and the stator armatures are stored in a single case. Thus it is possible to obtain a multi-shaft motor which enables different rotation speeds and torque for each output shaft.

[DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS]

The present invention will be described with reference to the accompanying figures. Fig. 1 shows the structure of a motor with a plurality of rotors according to a first embodiment of this invention. The motor having a plurality of rotors according to the first embodiment rotates two motors independently by passing a composite current in the stator coils 16 via a single common stator armature 14. The motor with a plurality rotors disposes a first rotor 2 and a second rotor 3 lengthwise in an axial direction in the case 1. The output shaft (A shaft) 4 of the first rotor 2 is provided in a double structure concentric to the output shaft (B shaft) of the second rotor 3. Permanent magnets (A magnets) 6 with three pairs of magnetic poles are provided on the first rotor 2. Permanent magnets (B magnets) 7 with four pairs of magnetic poles are provided on the second rotor 3. The magnetic pole number and magnetic pole ratio of the permanent magnets is not particularly limited and the above ratios and the numbers are merely examples.

A single core 11 is disposed so that a stator armature 14 is formed on an outer side of the first and second rotors 2, 3. Twelve slots 15 are formed with respect to the core 11 and stator coils 16 are wound thereon.

It is possible to rotate the first rotor 2 and the second rotor 3 independently by passing a composite current through the stator coils 16 in this motor with separated cores. This principle is described in detail in JP-A-10-77449 which is a prior application made by the present inventors. The controller for the rotation drive system in the present embodiment will be described below.

Next the assembled integrated structure of the stator armature 14 in a motor with a plurality of rotors will be described below. The outer peripheral side of the slot 15 of the core 11 is formed in a trapezoid shape so that the outer side is narrow and the inner side is wide. Fixing pins 18 are inserted into twelve respective slots 15 so that the perpendicular cross section in an axial direction is trapezoid.

Fixing rings 21, 22 are mounted to face each other on respective inner faces of the lengthwise end plates of the case 1. Ring-shaped grooves 23, 24 are formed in mutually opposed faces of the fixing rings 21, 22. When the stator armature 14 is assembled and integrated into the case 1, both ends in an axial direction of each fixing pin 18 is press fitted into the respective ring-shaped grooves 23, 24. A strengthening ring 25 is disposed in a lengthwise intermediate position of the first rotor 2 and the second rotor 3 to make close contact with an inner peripheral face of the core 11 of the stator armature 14.

In a motor with a plurality of rotors with this structure, the stator armature 14 is assembled in the case 1 and the lengthwise end plates are attached. Both axial ends of each fixing pin 18 are press fitted respectively to the respective ring-shaped grooves 23, 24 of the fixing rings 21, 22. In this manner, the respective fixing pins 18 support an outward force in a radial direction and press the outer peripheral section of each slot 15, 17. Thus the core 11 is integrated with the case 1 by the fixing pins 18. Furthermore since both axial ends of each fixing pin 18 support the outwardly pressing force, although an intermediate section in an axial direction tends to bend inwardly, the intermediate axial section of the fixing pins 18 are pressed together with a strengthening ring 25 and the core 11 in order to make close contact with the strengthening ring 25 and the core 11. This allows the intermediate position in an axial direction of the stator armature 14 to be integrated.

The controller for a rotation drive system of the motor with a plurality of rotors has a circuit structure as shown in Fig. 2. The stator coils 16 have twelve phases and a composite current is supplied to the stator coils. Thus an inverter 112 is provided in order to convert a direct current from a power source 111 such as a battery to an alternating current. In

order to make the sum of all instantaneous currents is zero, the inverter 112 is equivalent to a normal three-phase bridge-type inverter converted to twelve-phases. The inverter 112 comprises twenty-four switch elements provided on upper and lower positions and an equal number of diodes. The ON/OFF gate signal given to each gate of the inverter 112 is a PWM signal.

Since each rotor 2, 3 is rotated in synchrony, rotation angle sensors 113, 114 such as rotary encoders or resolvers are provided in order to detect the phase of each rotor 2, 3. A PWM signal based on required torque data for the first rotor 2 and the second rotor 3 (that is to say, the torque command) is generated in the control circuit 115 into which signals from these sensors 113, 114 are input.

A single coil 16 is formed on the stator armature 14 in a motor with plurality of rotors in this type of circuit structure. One of the rotors performs as a motor by passing a composite current in order to generate the same number of rotating magnetic fields as the number of rotors in the single stator coil 16. When the remaining rotor functions as a generator, since a current merely equivalent to the difference of the motor drive power and the generated power needs to be applied to the single coil, it is possible to greatly enhance efficiency.

A single inverter 112 may be provided with respect to the two rotors 2, 3. Furthermore when one of the rotors 2, 3 acts as a motor and the other acts as a generator, since a current merely equivalent to the difference of the motor drive power and the generated power needs to be applied to the single coil as described above, it is possible to reduce the capacitance of the electrical switching transistor of the inverter 112. In this manner, it is possible to enhance switching efficiency and to improve overall efficiency.

In the first embodiment, a first rotor 2 and a second rotor 3 are disposed lengthwise in an axial direction and the periphery of the rotors is encircled by the common cylindrical stator armature 14. Thus it is possible use a cylindrical member rather than the drum-shaped member in the rotors 2, 3. It is also possible to increase the rotation speed. In addition, since the plurality of rotors 2, 3 are disposed lengthwise, it is possible to maintain magnetic properties for long periods without creating a demagnetization effect since poles of equal polarity in the permanent magnets in the respective rotors are not opposed.

A second embodiment of a motor with a plurality of rotors will be described below with reference to Fig. 3 and Fig. 4. The motor with a plurality of rotors according to a second embodiment is arranged in the same structure so that two motors are arranged lengthwise in a single case. This motor with a plurality of rotors disposes a first rotor 2 and a second

rotor 3 lengthwise in an axial direction of the case 1. The output shaft (A shaft) 4 of the first rotor 2 is disposed concentric to the output shaft (B shaft) 5 of the second rotor 3 in a double structure. A permanent magnet (A magnet) 6 having 3 pairs of magnetic poles is disposed on the first rotor 2. A permanent magnet (B magnet) 7 having four pairs of magnetic poles is disposed on the second rotor 3.

An A core 11 and a B core 12 are disposed to comprise stator armatures 14A, 14B on an outer peripheral side of the first and second rotors 2, 3. Twelve slots 15A are formed with respect to the A core 11 with stator coils 16A wound thereon. Twelve slots 15B are formed with respect to the B core 12 with stator coils 16B wound thereon.

The motor with a plurality of rotors according to the second embodiment electrically connects the stator coils 16A, 16B in parallel and applies a composite current. Thus it is possible to rotate the first rotor 2 and the second rotor 3 separately. This principle is described in detail in the specification of Tokkai Hei 10-77449 which is an earlier application made by the present inventors. Furthermore the controller of the rotation drive system will be described below.

The integrated structure of the stator armatures 14A, 14B in a motor with a plurality of rotors according to the second embodiment is the same as that shown in Fig. 1 with respect to the first embodiment. The outer peripheral side of the slots 15A of the A core 11 and the outer peripheral side of the slots 15B of the B core 12 are both formed in a trapezoid shape so that an outer side is narrow and an inner side is wide. Fixing pins 18 which are trapezoid in an axial vertical cross section are inserted into the twelve respective slots 15A, 15B connected lengthwise. Fixing rings 21, 22 are mounted so face one another on respective inner faces of the lengthwise end plates of the case 1. Ring-shaped grooves 23, 24 are formed on opposed faces of the strengthening rings 21 22 and stators 14A, 14B are assembled and integrated in the case 1. Both axial ends of each fixing pin 18 are press fitted into the respective ring grooves 23, 24. A strengthening ring 25 is disposed in the space between the A core 11 of the stator armature 14A and the B core 12 in the stator armature 14B so that the outer periphery of the strengthening ring 25 makes close contact with the inner face of each fixing pin 18.

The controller of the rotation drive system of the motor with a plurality of rotors according to the second embodiment with the above structure will be described with respect to Fig. 4. The stator coils 16A, 16B are both formed from twelve phases. The stator coils 16A, 16B are connected to the output of the common inverter 112 in order to supply the composite current in parallel to the stator coils 16A, 16B. Other constitutive

components are common to the first embodiment as shown in Fig. 2.

In a motor with a plurality of rotors with the above circuit structure, a common composite current is supplied to the stator coils 16A, 16B of the respective stator armatures 14A, 14B, a number of rotating magnetic fields which is equal to the number of rotors is generated. Thus it is possible to rotate the rotors 2, 3 at the same time at different speeds and torque and extract that output. That is to say, the two rotors 2, 3 can be used as two independent motors stored in a single case 1. Moreover it is possible to extract the output of the differing speed and torque by supplying the same current from the common inverter 112 to these motors.

In the second embodiment in the same way as the first embodiment, a first rotor 2 and a second rotor 3 are disposed lengthwise in an axial direction and the periphery of the rotors is encircled by the respective cylindrical stator armatures 14, 14B. Thus it is possible use a cylindrical member rather than a drum-shaped member in the rotors 2, 3. It is also possible to increase the rotation speed. In addition, since the plurality of rotors 2, 3 are disposed lengthwise, it is possible to maintain magnetic properties for long periods without creating a demagnetization effect since poles of equal polarity in the permanent magnets in the respective rotors are not opposed.

A third embodiment of a motor with a plurality of rotors will be described below with reference to Fig. 3 and Fig. 5. The third embodiment is structurally equivalent to the second embodiment as shown in Fig. 3. The controller for a rotating drive system has a circuit structure as shown in Fig. 5. That is to say, the second embodiment was adapted to control two independent motors with a common power source by connecting the stator coils 16A, 16B of the respective two stator armatures 14A, 14B to the inverter 112. However in the present embodiment, the stator coils 16A,16B are connected in series at each phase as follower coils. Each terminal end on the side of the stator coil 16B is connected in common.

The twelve-phase composite current supplied by the inverter 112 is supplied to the coils of respective electrical phases and finally reaches a common final terminal connection point. In order to make the sum of all instantaneous currents zero, the current at the terminal connection point is zero.

In the third embodiment, this type of control circuit structure allows a plurality of rotors 2, 3 to be rotated independently at differing speeds by an electrical force supplied from a common inverter in the same manner as the second embodiment.

Furthermore a first rotor 2 and a second rotor 3 are disposed lengthwise in an axial direction and the periphery of the rotors is encircled by cylindrical stator armatures 14, 14B. Thus it is possible use a cylindrical member rather than a drum-shaped member in the rotors 2, 3. It is also possible to increase the rotation speed. In addition, since the plurality of rotors 2, 3 are disposed lengthwise, it is possible to maintain magnetic properties for long periods without creating a demagnetization effect since poles of equal polarity in the permanent magnets in the respective rotors are not opposed.

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 is a front and a lateral cross sectional view showing the structure of a first embodiment of this invention.

Fig. 2 is a block circuit diagram showing the structure of a controller for a rotating drive system according to a first embodiment.

Fig. 3 is a front and a lateral cross sectional view showing the structure of a second embodiment of this invention.

Fig. 4 is a block circuit diagram showing the structure of a controller for a rotating drive system according to a second embodiment.

Fig. 5 is a block circuit diagram showing the structure of a controller for a rotating drive system according to a third embodiment.

[EXPLANATION OF THE NUMERALS]

1	CASE
2	FIRST ROTOR
3	SECOND ROTOR
6	PERMANENT MAGNET (A MAGNET)
7	PERMANENT MAGNET (B MAGNET)
11	STATOR CORE
12	STATOR CORE
13	STATOR CORE
14, 14A, 14B	STATOR ARMATURE
16, 16A, 16B	STATOR COIL
111	POWER SOURCE
112	INVERTER
113, 114	ROTATION ANGLE SENSOR
115	INVERTER